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November 17, 2008

**To:** Environmental Protection Agency  
Cincinnati Procurement Operations Division  
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**Attention:** Ms. Tammy Thomas  
Contract Officer

**From:** Peter Morgan  
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**Subject:** Work Plan for Work Assignment 1-09, EPA Contract EP-C-07-028, under SwRI  
Project 03.14175, SwRI Proposal No. 03-54043.

Contract Title: "Testing and Related Support for Energy Bill-Mandated  
Activities"

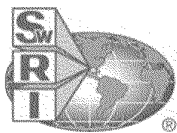
Assignment Title: "Comprehensive Gasoline Light Duty Exhaust Fuel Effects  
Test Program to Cover Multiple Fuel Properties and Two Ambient Test  
Temperatures, Interim Testing"

## 1.0 INTRODUCTION

Section 1506 of the Energy Policy Act of 2005 (Energy Act) requires EPA to produce an updated fuel effects model representing the 2007 light duty gasoline fleet, including determination of the emissions impacts of increased renewable fuel use.

The use of ethanol in gasoline has increased more than five-fold since 2000, and it is likely that its use will continue to expand into the next decade. It is also likely that use of high-level blends such as E85 will expand significantly.

Additionally, recent investigation related to the Mobile Source Air Toxics (MSAT2) rulemaking has shown that hydrocarbon emissions from light duty gasoline vehicles increase significantly as test temperature is decreased. As a result, the MSAT2 rulemaking promulgated NMHC standards at 20°F. However, this being a relatively new area of study, fuel effects data at temperatures lower than 72°F are scarce for use in emissions models.



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Hydrocarbon (HC) emissions are composed of hundreds of compounds, some of which have been identified by the EPA as air toxics. The Clean Air Act directs EPA to set standards to reduce air toxics emissions. Most existing data on the fractional relationship between the various air toxics and HC emissions has been established using vehicles meeting Tier 0 emissions standards (now more than 10 years old), and burning fuels that did not contain ethanol.

In order to help EPA develop a better understanding of the impact of ethanol fuel blends on light duty vehicle emissions, Southwest Research Institute® (SwRI®) will conduct Work Assignment 1-09, "Comprehensive Gasoline Light Duty Exhaust Fuel Effects Test Program to Cover Multiple Fuel Properties and Two Ambient Test Temperatures, Interim Testing". SwRI will comply with the requirements of Work Assignment 1-09 as described in the EPA Statement of Work.

## **2.0 OBJECTIVES**

EPA has a Light Duty Exhaust Fuel Effects Test Program which is currently in progress (WAs 0-01, 1-01, 1-02, 1-04). The initial data have raised several questions. The objective of WA 1-09 is to investigate other cycles with Tier 2 vehicles and Tier 1/NLEV vehicles. As with the previous WAs mentioned, our objectives are still:

- Multiple levels of ethanol in gasoline will be examined in this test program, along with ethanol's interactions with other fuel properties, e.g., volatility and distillation parameters.
- Varying levels of aromatics will also be evaluated, as they continue to be of interest due to their relationship to emissions of air toxics and the formation of particulate matter in the atmosphere.
- Total hydrocarbon (THC), non-methane hydrocarbons (NMHC), non-methane organic gas (NMOG), oxides of nitrogen (NO<sub>x</sub>), nitrogen dioxide (NO<sub>2</sub>), carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), particulate matter (PM), nitrous oxide (N<sub>2</sub>O), ammonia (NH<sub>3</sub>) and hydrogen cyanide (HCN) emissions will be measured in newer (Tier 2) vehicles, as well as Tier 1/NLEV, vehicles.
- This program will also generate speciated volatile organic compound (speciated VOC) data. VOC compounds of interest include C<sub>1</sub> – C<sub>12</sub> hydrocarbons as well as light alcohols and carbonyls.

SwRI will perform vehicle preparation and driving tests to generate analytical data on exhaust gas emissions. SwRI will also generate electronic reports and databases, as well as quality assurance documentation.

This is a follow-on WA to compliment work described under Phase 1 of WAs 0-01 and 1-01.

### **3.0 SCOPE OF WORK**

This work assignment requires SwRI to test eight test vehicles using three fuels. The vehicles and fuels have been procured under WAs 0-01 and 1-04 with exception of two vehicles. These two vehicles will be provided by the Coordinating Research Council (CRC), and are designated as Vehicle #204 – 1999 Honda Accord and Vehicle #205 – 2001 Toyota Corolla. SwRI will also provide engineering, technical, and quality assurance support for this project. Engineering support includes facility design, test plan development, and general oversight of data collection activities. Technical support includes installing and maintaining all instrumentation and support equipment, as well as calibration, testing, and data processing activities. Quality assurance support includes reviewing existing standard operating procedures, preparing quality-related documentation, developing miscellaneous operating procedures as needed, and reviewing raw and processed data prior to delivery to EPA. Details of the project are presented below.

#### **3.1 Work Plan Development**

This document represents the current Work Plan.

#### **3.2 Quality Assurance Project Plan and Quality Management Plan (QAPP/QMP)**

The Quality Assurance Project Plan submitted for WA 0-02 will remain in effect for the Work Assignment. It will be modified as necessary for this WA.

#### **3.3 Vehicle Recruitment**

SwRI is currently leasing 19 test vehicles as described in Table 1. These vehicles were procured under WA 0-01, and will be retained for additional testing under WA 1-09 and future anticipated WAs. The budget for this WA includes the cost of vehicle leasing only during the performance of the work described herein, which is anticipated to take approximately one month.

**TABLE 1. TEST VEHICLES FOR RECRUITMENT**

MAKE	YEAR	BRAND	MODEL	ENGINE	FAMILY	T2 BIN	NOTE
GM	2008	Chevrolet	Cobalt	2.4L I4	8GMXV02.4025	5	
GM	2008	Chevrolet	Impala	3.5L V6	8GMXV03.9052	5	FFV
GM	2008	Saturn	Outlook	3.6L V6	8GMXT03.6151	5	
GM	2008	Chevrolet	C1500 Silverado	5.3L V8	8GMXT05.3373	5	FFV
Toyota	2008	Toyota	Corolla	1.8L I4	8TYXV01.8BEA	5	
Toyota	2008	Toyota	Camry	2.4L I4	8TYXV02.4BEA	5	
Toyota	2008	Toyota	Sienna	3.5L V6	8TYXT03.5BEM	5	
Toyota	2008	Toyota	Tundra	4.0L V6	8TYXT04.0AES	5	
Ford	2008	Ford	Focus	2.0L I4	8FMXV02.0VD4	4	
Ford	2008	Ford	Taurus	3.5L V6	8FMXV03.5VEP	5	
Ford	2008	Ford	Explorer	4.0L V6	8FMXT04.03DB	4	
Ford	2008	Ford	F150	5.4L V8	8FMXT05.44HF	8	FFV
Chrysler	2008	Dodge	Caliber	2.4L I4	8CRXB02.4MEO	5	
Chrysler	2008	Dodge	Caravan	3.3L V6	8CRXT03.3NEP	8	FFV
Chrysler	2008	Jeep	Liberty	3.7L V6	8CRXT03.7NE0	5	
Honda	2008	Honda	Civic	1.8L I4	8HNXV01.8LKR	5	
Honda	2008	Honda	Accord	2.4L I4	8HNXV02.4TKR	5	
Honda	2008	Honda	Odyssey	3.5L V6	8HNXT03.54KR	5	
Nissan	2008	Nissan	Altima	2.5L I4	8NSXV02.5G5A	5	

For WA 1-09, SwRI will use a subset of six vehicles from those previously procured for testing as described in Table 2.

**TABLE 2. TEST VEHICLES FOR WA 1-09**

MAKE	YEAR	BRAND	MODEL	ENGINE	FAMILY	T2 BIN	NOTE
GM	2008	Chevrolet	C1500 Silverado	5.3L V8	8GMXT05.3373	5	FFV
Toyota	2008	Toyota	Camry	2.4L I4	8TYXV02.4BEA	5	
Ford	2008	Ford	Focus	2.0L I4	8FMXV02.0VD4	4	
Chrysler	2008	Dodge	Caravan	3.3L V6	8CRXT03.3NEP	8	FFV
Honda	2008	Honda	Accord	2.4L I4	8HNXV02.4TKR	5	
Nissan	2008	Nissan	Altima	2.5L I4	8NSXV02.5G5A	5	

Two additional CRC provided vehicles, as described in Table 3, will be shipped from Automotive Testing Laboratories (ATL). The cost of round-trip shipping between ATL and SwRI is included in the attached cost estimate.

**TABLE 3. CRC TEST VEHICLES**

MAKE	YEAR	BRAND	MODEL	ENGINE	FAMILY	T1	NOTE
Honda	1999	Honda	Accord	2.3L	XHNXV02.3PA3	NLEV	
Toyota	2001	Toyota	Corolla	1.8L	1TYXV01.8FFA	NLEV	

### 3.4 Test Lubricants

Engine lubricants for this program have been provided by the EPA under WA 0-01.

### 3.5 Test Fuels

The required test fuels (Fuel 17, Fuel 18, and Fuel 19) are already in SwRI's possession. Fuel procurement, analyses, storage, and handling for this project are covered under WA 1-04.

SwRI will inform the EPA WAM if there is a shortage of these fuels and EPA will ship additional drums which were also blended for this project, from their Ann Arbor laboratory.

SwRI will utilize fuel storage and handling practices that will minimize, to the greatest extent possible, any changes in test fuel properties or mislabeling of fuel drums, or any other possible situations which could lead to misfueling of the test vehicles. These practices will include the storage of test fuels in sealed 5B drums, indoors, at temperatures not exceeding 72°F.

Furthermore, to assure that no drums are mislabeled, SwRI will confirm fuel properties listed in Table 4 using a Petrospec analyzer each time a new drum is opened. Additionally, unique alphanumeric labels assigned to individual drums will be recorded each time a vehicle is fueled.

**TABLE 4. TEST FUEL PROPERTIES TO BE CONFIRMED USING THE PETROSPEC**

ETHANOL CONTENT OF THE FUEL, VOL. %	FUEL PROPERTIES TO BE CONFIRMED
0 - 15	Ethanol content, aromatic content, T90
>15	Aromatic content, T90

Fuel Speciation will be performed on Fuels 17, 18 and 19. SwRI will provide detailed hydrocarbon analysis using ASTM method D6729.

### 3.6 Vehicle Preparation

All vehicle preparations were completed under WA 0-01 with exception of the CRC test vehicles. These vehicles will undergo a thorough inspection before beginning the test preparation sequence. The inspection and preparation list can be found in Appendix A. SwRI will perform maintenance and repairs needed to be sufficient for safe and reliable operation of the vehicles on

chassis dynamometers. SwRI will also collect and record vehicle information for entry into MSOD data tables.

Following the inspection, each vehicle will receive an oil change followed by conditioning for 250 miles.

Following the conditioning, a single FTP test will be performed using a baseline fuel (TBD) with phase-level measurements of THC, NMHC, NO<sub>x</sub>, CO, and PM emissions. The results of these initial tests will be submitted to the EPA WAM for review to determine the vehicles' acceptability for the test program. If accepted by EPA, an approved candidate vehicle may begin preparations for testing as outlined below.

If any test vehicle is equipped with traction control, SwRI will ensure that the latter is disabled either through an interior disable button or other method (remove power fuse to antilock brake system (ABS)), and place a placard in the vehicle indicating the method of disabling traction control if driver input is required.

Dyno set coefficients will be determined at a later date for the two vehicles shipped from ATL. The test weight (ETW) and target coefficients for each vehicle must be approved by the EPA WAM. For the purpose of this study, the agreed road load setting will remain the same for all testing on a given vehicle including the cold temperature testing.

### **3.7 Vehicle Testing**

This work plan covers the testing of eight vehicles with three test fuels. All vehicle soaks and tests will be conducted at a nominal temperature of 72°F. SwRI will make a good faith effort to maintain intake air temperature and humidity during testing at 72±2°F and 75±5 grains H<sub>2</sub>O/lb dry air, respectively.

All vehicles will be tested on all test fuels using the Federal Test Procedure (FTP) as a three-phase, cold-start test at FTP ambient and load conditions. All tests on a given vehicle will be conducted using the same 48-inch single roll electric chassis dynamometer. It is expected that a single test site will be used for this entire program. The same driver will be used for all tests on a given vehicle; however, it may be necessary to use more than one driver in the program.

For PM samples, a proportionality statistic will be calculated. For other emissions, SwRI will verify that the tunnel flow remained constant during the test. The CVS blower will be kept on for twenty minutes before the first emission test on a given day and continuously between emission tests to ensure tunnel stability.

SwRI will provide defined and maintained cooling fan placement and flow for each test vehicle on all the tests. The flow of air sweeping the vehicle in the test cell will be consistent between tests.

Prior to any emission test conducted in this program, the representative bulk oil temperature in the sump will be stabilized within to  $72 \pm 3^\circ\text{F}$ .

Test fuels will be tested in each vehicle at  $72^\circ\text{F}$  in the follow sequence: Fuel 19 (E15), Fuel 18 (E10), followed by Fuel 17 (E0).

Each vehicle will be tested at least twice on each fuel. After two tests have been completed and the acquired data have passed all quality control verifications, the need for a third test will be determined by following the variability criteria shown in Table 5. If the ratio of any of the criteria ( $\text{CO}_2$ ,  $\text{NO}_x$ , NMHC) on a pair of tests for a given vehicle/fuel combination exceeds the levels shown in Table 5, a third test will be conducted. A PM criterion was considered, but WA 1-02, Amendment 1 eliminated it. If a third test is needed, the EPA WAM will be notified (typically within 24 hours) and the summary data for the test pair in question will be provided. For budgeting purposes, this Work Plan assumes that 15 percent of all test pairs will require a third test. If the actual need to conduct a third test exceeds the 15-percent allocation, the project will incur additional costs. (Likewise, if the actual need to conduct a third test is less than 15 percent, the project will incur less costs than those given in the attached estimate.)

**TABLE 5. VARIABILITY CRITERIA FOR TRIPLICATE TESTING**

<b>DILUTE GASEOUS EMISSION</b>	<b>CRITERIA FOR REQUIRING A THIRD TEST (COMPOSITE CYCLE EMISSIONS)</b>
$\text{CO}_2$	Ratio of higher / lower > 1.04
$\text{NO}_x$	Ratio of higher / lower > 1.81
NMHC	Ratio of higher / lower > 1.67
Crank Time	Ratio of higher - lower > 1.00

If the crank times exceed the criteria shown in Table 5 on a pair of tests for a given vehicle/fuel combination during the cold or hot starts, respectively, a review of the information available on the cranking events will be performed to determine if an additional emissions test is necessary. In such a case, the additional test must be approved by the EPA WAM.

SwRI anticipates conducting approximately 12 tests per week. Testing will be conducted during one shift while vehicle preparation and preconditioning will be conducted during a second shift. This level of effort will require some overtime from core laboratory staff. An allocation for premium pay has been included in the attached budget.

### ***3.7.1 Fuel Change and Test Execution Sequence***

The fuel change and vehicle preconditioning sequence is given in Table 6.



**TABLE 6. FUEL CHANGE AND TEST EXECUTION SEQUENCE**

STEP	DESCRIPTION
1	Drain vehicle fuel completely via fuel rail whenever possible.
2	Turn vehicle ignition to RUN position for 30 seconds to allow controls to allow fuel level reading to stabilize. Confirm the return of fuel gauge reading to zero.
3	Fill fuel tank to 40% or 7 gallons (whichever is lower) with next test fuel in sequence. Fill-up fuel must be less than 50°F.
4	Start vehicle and execute catalyst sulfur removal procedure described in Appendix C of CRC E-60 Program report. Engine oil temperature in the sump will be measured and recorded during the sulfur removal cycle.
5	Four vehicle coast downs from 70 to 30 mph will be performed with the last two measured and monitored to establish tolerances for each vehicle for use in upcoming WA 1-03. A vehicle's average coastdown time from an individual fuel change sequence will be compared to the average of all coastdown times for that vehicle. If the individual run deviated from the overall average by more than $\pm 5\%$ , the vehicle will be checked for any obvious and gross source of change in the vehicle's mechanical friction. The results obtained during WAs 1-01, 1-02, and 1-09 will be used to establish repeatability criteria to be used during WA 1-03.
6	Drain fuel and refill to 40% or 7 gallons (whichever is lower) with test fuel. Fill-up fuel must be less than 50°F.
7	Soak vehicle at 50°F (nominal) for at least 12 hours to allow fuel temperature to stabilize to the test temperature.
8	Move vehicle to test area without starting engine. Start vehicle and drive one 3-phase FTP cycle. Allow vehicle to idle in park for two minutes before engine shutdown.
9	Move vehicle to soak area without starting or driving.
10	Park vehicle in soak area at 50°F (nominal) for 12-36 hours. During the soak period, maintain the nominal charge of the vehicle's battery using an appropriate charging device.
11	Move vehicle to test area without starting engine.
12	Perform FTP cycle emissions test.
13	Move vehicle to test area without driving.
14	Park vehicle in soak area at 50°F (nominal) for 12-36 hours. During the soak period, maintain the nominal charge of the vehicle's battery using an appropriate charging device.
15	Move vehicle to test area without driving.
16	Perform FTP cycle emissions test.
17	Determine whether third replicate is necessary, based on data variability criteria (see Table 5).
18	If a third replicate is required, repeat steps 13, 14, 15 and 16.
19	If third replicate is not required, return to Step 1 and proceed with next fuel in test sequence.

### **3.7.2 Test Sequence**

The WA is for testing of Fuel 19 (E15), Fuel 18 (E10) and Fuel 17 (E0).

Under WA 0-01 SwRI determined and verified sample flow rates that provide proportionality. Those same flow rates will be used for WA 1-09. The CVS blower will be kept on for approximately 20 minutes before the first emission test on a given day and continuously between emission tests to ensure tunnel stability.

SwRI has made allocations to conduct one (1) “blank” FTP test during this program. This test will involve running the full test sequence drawing only background air into the sampling system. All sampling systems will be operated and measurements will include:

- Phase level THC, CH<sub>4</sub>, CO, NO<sub>x</sub>, CO<sub>2</sub>, PM, ethanol by INNOVA, NO<sub>2</sub>, VOCs (including aldehydes and alcohols)
- Continuous THC, NMHC, CO, NO<sub>x</sub>, CO<sub>2</sub>, N<sub>2</sub>O, NH<sub>3</sub>, and HCN

### **3.7.3 Determination of Phase Level and Continuous Regulated Emissions**

Phase-level (bag-by-bag) emissions to be determined and reported, and light-duty FTP weighting factors will be used to calculate composite emissions. The following emissions rates will be determined:

- total hydrocarbons (THC)
- non-methane hydrocarbons (NMHC)
- non-methane organic gases (NMOG) as specified in Section 3.7.5 below
- oxides of nitrogen (NO<sub>x</sub>)
- nitrogen dioxide (NO<sub>2</sub>) will be determined by the difference of measured NO and NO<sub>x</sub> values as well as by continuous mass spectroscopy
- carbon monoxide (CO)
- carbon dioxide (CO<sub>2</sub>)
- particulate matter (PM)
- ethanol

Additionally, THC, NMHC, CO, CO<sub>2</sub> and NO<sub>x</sub>, emissions will be determined on a continuous basis (1 Hz) from raw “modal” samples at the tailpipe position only. Although not required, these measurements will be made for all tests in order to maintain a consistent raw exhaust sample extraction rate.

The unweighted, integrated mass emissions by phase and for the entire test for the continuous THC, NMHC, CO, CO<sub>2</sub>, NO<sub>x</sub>, will be compared to the mass emission values measured by the mechanically integrated (bag) CVS samples. For only the unweighted,

integrated mass emissions for the entire test, the following maximum deviations from the CVS measurements will be used as guidelines until appropriate criteria can be developed:

- THC:  $\pm 15\%$
- NMHC:  $\pm 15\%$
- CO:  $\pm 10\%$
- CO<sub>2</sub>:  $\pm 5\%$
- NO<sub>x</sub>:  $\pm 10\%$

The WA requests that a direct exhaust flow measurement device, such as a SEMTECH EFM from Sensors Inc., be used. However, SwRI determined during WA 0-01 that the EFMs as installed in SwRI's test site did not provide accurate exhaust flow measurement. This issue was addressed separately under WA 1-06. For this WA, exhaust flow will be calculated using the EFM and corrected in post processing.

Additional available data will be acquired at least 1 Hz from each vehicle's onboard diagnostic (OBD) system during all emissions tests using a DBK70 data acquisition system. The available data are expected to include:

- RPM
- Vehicle speed
- Engine load
- Short term fuel trim-bank 1
- Long term fuel trim-bank 1
- MIL status
- Absolute throttle position
- Engine coolant temperature
- Short term fuel trim-bank 2
- Long term fuel trim-bank 2
- PID \$44 Fuel/air commanded equivalence ratio
- Alcohol fuel percent
- Manifold absolute pressure
- Spark advance
- PID \$42 Control Module Voltage
- Purge

It should be noted that some of the parameters listed above may not be accessible for a specific vehicle.

### ***3.7.4 Speciation of Volatile Organic Compounds***

Phase-level (bag-by-bag) speciated VOCs will include C<sub>1</sub>-C<sub>12</sub> hydrocarbons as well as light alcohols, aldehydes, and ketones. Sampling and analysis of C<sub>2</sub>-C<sub>12</sub> hydrocarbons will be

conducted in a manner similar to CARB method 1002/1003, "Procedure for the Determination of C<sub>2</sub>-C<sub>12</sub> Hydrocarbons in Automotive Exhaust Samples by Gas Chromatography". Sampling and analysis of alcohols will be done using CARB method 1001, "Determination of Alcohols in Automotive Source Samples by Gas Chromatography". Sampling and analysis of carbonyl compounds will be conducted in a manner similar to CARB method 1004, "Determination of Aldehyde and Ketone compounds in Automotive Source Samples by High Performance Liquid Chromatography". Analysis of C<sub>1</sub> – C<sub>4</sub> HC samples will be done within one hour of completion of the emissions test. Subsequent analysis of the additional compounds of interest will be done within 4 hours of emission test completion. The time between sample collection and the start of C<sub>1</sub>-C<sub>4</sub> HC analysis will be reported.

Sampling and analysis of light alcohols will be accomplished by bubbling exhaust through glass impingers containing deionized water and analyzing samples with a gas chromatograph. Analysis will include the following compounds: methanol, ethanol, isopropanol, n-propanol, n-butanol, and isobutanol.

VOC speciation for the 8 vehicles will only be conducted on samples from Phase 1 of the FTP test for all three test fuels. This also includes all repeat tests and is outlined graphically in Table 7.

**TABLE 7. VOC SPECIATION SUMMARY FOR 8 VEHICLES**

FTP TEST PHASE (BAG)	FTP TEST REPEAT		
	TEST 1	TEST 2	TEST 3 (IF NEEDED)
<b>Phase 1</b>	C <sub>1</sub> -C <sub>12</sub> Speciation Light Alcohols Carbonyls	C <sub>1</sub> -C <sub>12</sub> Speciation Light Alcohols Carbonyls	C <sub>1</sub> -C <sub>12</sub> Speciation Light Alcohols Carbonyls
<b>Phase 2</b>	none	none	none
<b>Phase 3</b>	none	none	none

During the analysis of C<sub>2</sub>-C<sub>4</sub> hydrocarbons, special consideration will be given to 1,3-butadiene. Because of the instability of 1,3-butadiene, the analysis of C<sub>2</sub>-C<sub>4</sub> hydrocarbon samples collected during Phase 1 of the test cycle will be initiated within one hour of collection. The speciation of C<sub>5</sub>-C<sub>12</sub> hydrocarbon samples collected in Phase 1 of the test cycle will be completed within 4 hours of collection. The time between sample collection and the start of C<sub>2</sub>-C<sub>4</sub> and C<sub>5</sub>-C<sub>12</sub> hydrocarbon analysis will be recorded. SwRI will make a good-faith effort to complete the analysis of C<sub>2</sub>-C<sub>4</sub> and C<sub>5</sub>-C<sub>12</sub> background hydrocarbon samples on the day they are collected.

Alcohol samples will be sealed and stored at a temperature below 40°F immediately following collection. A good-faith effort will be made to analyze these samples on the day they are collected, but no later than within six calendar days.

Samples of carbonyl compounds will be collected in cartridge type samplers. These samples will be extracted immediately following collection (within 15 minutes) and the extracts sealed and stored immediately at a temperature below 40°F. A good-faith effort will be made to analyze these extracts on the day they are collected, but no later than within three calendar days. This analysis will account for the presence of acrolein-x in the sample. The location of the acrolein-x peak in the HPLC chromatogram will be determined and, using the response factors derived from the calibration for acrolein, acrolein-x mass emissions will be quantified and reported.

Storage of alcohol and carbonyl samples will be segregated to prevent any cross-contamination of samples.

The following daily sequence will be used for the analysis of VOC samples:

- VOC samples collected in Phase 1 of the test cycle will be analyzed first, in the sequence of vehicle tests.
- Background samples will be analyzed last, in the sequence of vehicle tests.

### **3.7.5 *Determination of NMOG***

SwRI will calculate NMOG using a method to be determined and provided by EPA.

### **3.7.6 *Continuous Measurements of N<sub>2</sub>O, NH<sub>3</sub> and HCN***

Continuous and phase-integrated emissions of N<sub>2</sub>O, NH<sub>3</sub> and HCN will be measured using Fourier Transform Infrared Spectroscopy (FTIR). Although these measurements are only required during the first test of each fuel/vehicle combination, they will be taken during all test in order to maintain a consistent raw exhaust sample extraction rate.

#### **4.0 REPORTING AND DELIVERABLES**

##### **4.1 Weekly Reports**

SwRI will provide 30-60 minute telephone conference reports weekly that summarize progress to date. It is expected that this teleconference will cover WAs 1-01, 1-02, 1-04 and 1-09 together.

The oral report will indicate progress achieved in the preceding week, technical issues encountered, solutions to issues (proposed or attempted), and projected activity in the following week. This report will include any potential issues or circumstances that arise causing any delays in the testing.

SwRI will provide on a weekly basis to the WAM a report summarizing hours and dollars expended for individual tasks. The goal of the report is to identify as early as possible if costs in hours and dollars are exceeding that which has been budgeted for the program.

##### **4.2 Monthly Written Progress Reports**

SwRI will provide monthly progress reports. Invoices will be provided every four weeks according to the existing contract. The monthly progress reports will include information from the most recent invoice. The reports will track percentages of hours used in each task and whether the project is on schedule. They will explain problems encountered including resolutions and indicate if the schedule or budget is affected.

##### **4.3 Data Files**

SwRI will submit data file to EPA via a secure FTP site using the same file format developed during WAs 0-01 and 1-01.

##### **4.4 Mode of Delivery**

SwRI will deliver one set of files to the EPA WAM at the USEPA National Vehicle and Fuel Emissions Laboratory at Ann Arbor, Michigan. Data will be submitted via a secure method to be approved by the WAM. Under no circumstances will these files be delivered by insecure methods such as electronic mail attachments or First Class Mail.

##### **4.5 Draft Final Report**

SwRI will submit a draft final report to EPA within six weeks of all test completion under this Work Assignment. The report will detail the work completed including any issues encountered and will include:

- Vehicle recruitment procedures
- Vehicle-related information, VIN, mileage, emission system descriptions, etc.
- Measurement methodologies and quality measures.
- Test completion diary for individual vehicles detailing any relevant information regarding completion of each test.
- Summaries of all data collected in this work assignment. Graphical displays summarizing the data by fuel type and other relevant breakdowns.
- Check lists used to control WA specific test protocols.

#### 4.6 Final Report

SwRI will provide a final report incorporating EPA comments, within 30 days of receiving comments from EPA. The report will be in hard copy plus an agreed-upon electronic format such as Microsoft Word or Adobe portable document files (\*.pdf).

#### 5.0 STAFF ASSIGNMENTS

The SwRI Work Assignment Manager will be Mr. Kevin Whitney and the Principal Investigator will be Mr. Pete Morgan. Mr. Patrick Merritt will be the alternate Work Assignment Manager.

#### 6.0 PROJECTED LABOR HOURS AND OTHER DIRECT COSTS

Based on our understanding of Work Assignment 1-09, we project the breakdown of employee utilization by labor category as detailed in Table 8. Estimates for other direct costs are shown in Table 9. Complete cost details for this effort are presented in the attached cost breakdown shown in Appendix B. These costs assume the two CRC test vehicles will be tested after the completion of WA 1-02.

**TABLE 8. PROJECTED LABOR HOURS FOR WORK ASSIGNMENT 1-09**

LABOR CATEGORY	NUMBER OF HOURS
PL4	Ex. 4 - CBI
PL3	
PL2	
PL1	
Senior Technical	
Technical	
Clerical	
Total	
Total Technical Hours	

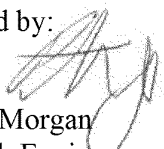
**TABLE 9. PROJECTED OTHER DIRECT COSTS FOR WORK ASSIGNMENT 1-09**

ITEM	PROJECTED OTHER DIRECT COSTS
Span gases	<b>Ex. 4 - CBI</b>
Nitrogen, zero air	
Sample filters	
Tedlar bags	
Exhaust pipe, flanges	
Swedgelock fittings	
Steel and teflon tubing	
Glassware	
HPLC and GC supplies	
Misc mechanical	
Misc electrical	
Misc chemical	
Monthly lease of 19 vehicles	
Maint./repair parts for CRC vehicles	
Mileage accumulation fuel	
<b>TOTAL</b>	

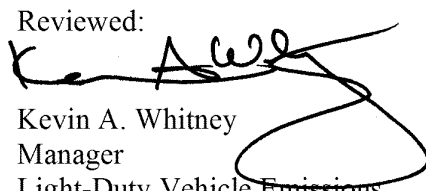
## 7.0 SUMMARY

Southwest Research Institute has responded to Work Assignment 1-09. Should any questions of a technical nature arise, please contact Mr. Pete Morgan at 210-522-3143 or Mr. Patrick Merritt at 210-522-5422. If there are questions regarding cost or contractual issues, please contact Ms. Sherry Twilligear at 210-522-3948. Thank you for this opportunity to be of service.

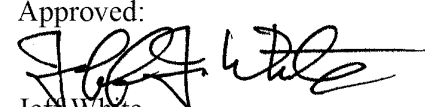
Prepared by:

  
Peter J. Morgan  
Research Engineer  
Light-Duty Vehicle Emissions

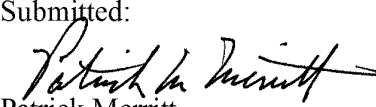
Reviewed:

  
Kevin A. Whitney  
Manager  
Light-Duty Vehicle Emissions

Approved:

  
Jeff White  
Director, Emissions Research and Development  
Engine, Emissions, and Vehicle Research Division

Submitted:

  
Patrick Merritt  
Senior Research Scientist  
Chemistry and Particle Science

c: Ms. Constance Hart, WAM, EPA-AA  
Mr. Rafal Sobotowski, Alternate WAM, EPA-AA  
Mr. Carl Fulper, EPA-AA  
Ms. Sherry Twilligear, SwRI Contracts

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**APPENDIX A**

**VEHICLE INSPECTION AND PREPARATION LIST**

## VEHICLE INSPECTION AND PREPARATION LIST

- 1) Inspection to see if additional maintenance is needed:
  - a. Cooling system
    - i. Leaks
    - ii. Antifreeze condition acceptable
    - iii. Hose quality/state
  - b. Transmission
    - i. Leaks
    - ii. Fluid condition acceptable
  - c. Engine
    - i. Oil leaks
    - ii. Ignition system – plugs/wires
    - iii. Check engine codes – report -
    - iv. Power steering fluid leaks/level
    - v. Serpentine belt condition
  - d. Axles
    - i. CV joints
    - ii. Leaks
  - e. Brakes
    - i. Pads (front) are intact
    - ii. Fluid level
  - f. Tires
    - i. Cracks, objects in tread, flat spots
  - g. Exhaust System
    - i. Check for holes from rust
    - ii. Check flanges and clamps for leaks
    - iii. Weep holes in mufflers plugged
    - iv. Photos taken of exhaust layout
  - h. Battery – Load test or confirm strong cranking speeds
- 2) Maintenance required
  - a. Air cleaner replacement
  - b. Oil and filter change
  - c. Fuel drain
  - d. Fuel filter if it is a normally maintenance item
  - e. Check engine codes repaired with approval
- 3) Run the catalyst sulfur removal procedure described in Appendix C of CRC E-60 Program report
- 4) Conditioning (approximately 250 miles based on PM/new oil study)
  - a. Brakes – clean rusty rotors/drums by driving
  - b. Oil break-in/burn-off light-ends
  - c. Exhaust clean-out – some wide open throttle/aggressive driving
  - d. Ignition system (plugs) clean from heat-no excessive idle instability
  - e. Transmission is shifting/behaving properly

**APPENDIX B**

**COST DETAIL FOR WORK ASSIGNMENT 1-09**

**Ex. 4 - CBI**

**Ex. 4 - CBI**

# Ex. 4 - CBI

# Ex. 4 - CBI

**Ex. 4 - CBI**



# Ex. 4 - CBI

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